

**INSECT DISEASE SURVEY IN  
BRITISH COLUMBIA 1964-1969**

**by**

**Oswald N. Morris and Patricia Olsen**

**FOREST RESEARCH LABORATORY  
CANADIAN FORESTRY SERVICE  
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A summary of the diagnosis of dead insects found in British Columbia forests between 1965 and 1969 inclusive is presented as a sequel to an earlier one covering diagnoses between 1947-1963. This list does not include diagnoses for 1964, when the senior author was absent from the laboratory. All 1967 diagnoses were performed by J.M. Burke of the Insect Pathology Research Institute, Sault Ste. Marie, Ontario. Approximately 3000 specimens, representing 69 insect species, were examined over the 5-year period. Table 1 lists the pathogens, insect species, location and year of collection.

Eleven species of fungi, notably Cephalosporium sp. and Entomophthora sp. (from the balsam woolly aphid, Adelges piceae (Ratz.), and the green-striped forest looper, Melanolophia imitata Wlk., respectively) were recorded from 30 insect species. Polyhedrosis viruses were recorded from 24 species and granulosis virus from 1 species. Electron photomicrographs of some of the nuclear polyhedrosis viruses are presented. Microsporidia were found in 30 species.

Bacilli identified to species were confirmed by Dr. H. de Barjac of the Pasteur Institute in Paris. The criteria for identification of the bacteria were oxygen requirements, fermentation of glucose, lactose, maltose, sucrose, xylose, mannitol, arabinose, cellobiose, fructose, galactose, mannose, raffinose, rhamnose, trehalose, dulcitol, inositol, sorbitol, dextrin, inulin, salicin, starch, and levulose. Other biochemical reactions were gelatin hydrolysis, indol, NO<sub>3</sub> Red, litmus milk, methyl red, H<sub>2</sub>S production,

V.P. test, ammonia (urea slant), citrate agar, citrate broth, phospholipase C, casein hydrolysis and gelatin liquefaction. Growth characteristics at various temperatures, and on special media (motility medium, blood agar, 5% NaCl broth), and cellular morphology of the nutrient agar plate, nutrient agar slant and nutrient broth forms were studied. Dr. de Barjac identified all the bacterial varieties and the serotype. Bacillus thuringiensis var. galleriae were recorded from 5 insect species, B. thuringiensis serotype I from 1, B. cereus from 6, B. brevis from 1, and Bacillus sp. from 29 insect species.

Table 2 summarized the different types of organisms isolated from each insect species with a view to determining, at a glance, the different pathogens by which each species is naturally affected.

Since this report completes the insect disease survey in British Columbia for the foreseeable future, it is appropriate to take a look at the insect disease picture over the entire 1947-1969 period. To this end, we used the annual insect and disease survey records to tabulate roughly the population fluctuations for the most important defoliators, then compared this information with the annual incidence of diseases in each species according to our records.

The results summarized in Table 3 should not be interpreted as for a definitive study of the epizootiology of the various diseases, but rather as showing a rough trend in the behavior of the diseases with respect to insect population changes.

The fluctuations of the oak looper, Lambdina fiscellaria somniaria, populations were generally well defined and the two peak population periods,

1947-1951 and 1958-1961, were accompanied by relatively high incidences of disease agents, especially nuclear polyhedrosis virus.

Following the severe 1947 outbreak, the western hemlock looper, L.f. lugubrosa, population decreased, and thereafter maintained a somewhat erratic low to moderate population fluctuation. The incidence of disease in 1947 was high and polyhedrosis virus probably helped to hold the insect in check between 1948 and 1956. During the next eight years, the population maintained a moderate level but apparently not with the overt help of disease. Between 1965 and 1969 microsporidia, fungi and bacteria apparently helped to keep the population in check. No doubt other insecticidal factors operate in the population, further knowledge of which would contribute to the eventual control of this serious pest.

The population fluctuation of the green-striped forest looper was well defined. In periods of high to moderate populations (1947-1953, 1957-1961, 1964-1969), epizootics of various disease agents, particularly fungus, were always evident.

The populations of Malacosoma pluviale and M. disstria generally maintained a high to moderate level throughout the 22-year survey period despite the presence of polyhedrosis and granulosis viruses, microsporidia, fungi and bacteria. The tent caterpillars would probably be good candidates for integrated chemical and biological control. Sublethal doses of chemical pesticides would probably increase the susceptibility of these pests to natural or artificially disseminated microbial agents.

In general, disease organisms were most prevalent during moderate to high population levels of Acleris variana, Orgyia pseudotsugata, Hyphantria cunea, Nypetia phantasmaria, Halisidota argentata, Ectropis crepuscularia

and Carpeta divisata. The fact that Choristoneura sp. maintained high populations for long periods (1958-1967) despite the presence of disease agents, suggests that the pathogens exert relatively little effect on the population dynamics of this insect.

The population levels and disease incidences remained generally low for Stilpnotia salicis, Venessa cardui, Neophasia menapia, Nymphalis antiopa and Orthosia hibisci over the 22-year survey period.

On the basis of these data, microorganisms apparently play an important role in the population dynamics of some forest insects of this province. This information should be taken into account in any projected chemical, biological or integrated control operations.

TABLE 1

A list of microorganisms recovered from forest insects in British Columbia from 1965-1969.

Microorganism	Name of insect	Locality	Year
FUNGUS			
<u>Cephalosporium</u> sp.	<u>Adelges piceae</u> (Ratz.)	Seymour Lake	1965
	<u>Eupithecia filmata</u> Pears	Fort Nelson	1967
	<u>Pikonema</u> sp.	Prince Rupert	1967
<u>Penicillium</u> sp.	<u>Adelges piceae</u> (Ratz.)	Seymour Lake	1965
	<u>Melanolophia imitata</u> Wlk.	Victoria	1965
	<u>Lambdina fiscellaria somnaria</u> Hulst.	Victoria	1965
	Microlepidoptera	Alaska Hwy-M510	1965
<u>Aspergillus</u> sp.	<u>Malacosoma pluviale</u> Dyar	Victoria	1965
<u>Empusa</u> sp.	<u>Malacosoma pluviale</u> Dyar	Victoria	1965
<u>Entomophthora</u> sp.	<u>Melanolophia imitata</u> Wlk	Fair Harbour	1967
		Misery Creek	1967
		Kelsey Bay	1967
		Slatery Bay	1967
		Port Eliza	1967
		Salmon Arm	1967
		Nesook Bay	1967
		Leballos Inlet	1967
		Lewis Inlet	1967
		Saliath Bay	1967
Port Neville	1967		
<u>Beauveria globulifera</u>	<u>Syngrapha rectangular nargenta</u> Ott.	Departure Bay	1967
<u>Harmodendrum</u> sp.	<u>Acleris variana</u> (Fern.) <u>Melanolophia imitata</u> Culk.	S. Van. Is.	1967
		S. Van. Is.	1967
<u>Spicaria</u> sp.	<u>Cephalcia</u> sp.	Prince Rupert	1967
<u>Beauveria</u> sp.	<u>Lambdina fiscellaria lugubrosa</u> Hulst.	Vanderhoof	1967
<u>Beauveria bassiana</u>	<u>Dendroctonus obesus</u> (Mann)	Victoria	1968
<u>Trichosporon</u> sp.	<u>Melanolophia imitata</u> Wlk.	Jeune Landing	1968
Fungus (unspecified)	<u>Adelges piceae</u> (Ratz.)	Seymour Lake	1965
	<u>Malacosoma pluviale</u> Dyar	Victoria	1965
	Microlepidoptera	Alaska Hwy-M510	1965

TABLE 1 (Cont.)

Microorganism	Name of insect	Locality	Year
<u>FUNGUS (Cont.)</u>			
Fungus (unspecified) (Cont.)	Noctuidae (unspec.)	Uslinka Lake Rd.	1965
	<u>Petrova albicapitana</u> (Busck)	West Grand Forks	1965
	<u>Neophasia menapia</u> Feld.	O.K. Landing	1965
	<u>Eupithecia annulata</u> Hulst.	Rutland	1965
	<u>Eupithecia</u> sp.	Boswell	1965
	<u>Operophtera bruceata</u> Hulst.	Vernon	1965
	Teuthredinidae	Dawson Creek	1965
	<u>Ectropis crepuscularia</u> Schiff.	Port Mellon	1966
	<u>Melanolophia imitata</u> Wlk.	Nelson Creek	1966
		Rolley Lake	1966
		Burnet Creek	1966
		Trout Lake	1966
		Stuart Is.	1966
	<u>Malacosoma pluviale</u> Dyar	Victoria	1966
	<u>Zeiraphera</u> sp.	Osoyoos	1966
	<u>Nyctobia limitaria</u>		
	<u>nigroangulata</u> Stkr.	Blue River	1966
	<u>Pseudohazia eglanterina</u> (Bdv.)	Langford	1966
	<u>Choristoneura fumiferana</u> (Clem)	White Wood Creek	1966
		Smithers Landing	1966
	<u>Acleris variana</u> (Fern.)	Nelson Dist.	1966
	<u>Epinotia</u> sp.	Holberg	1966
	<u>Eupithecia</u> sp.	Sheridan Lake Rd.	1966
	Tortricidae	Alaska Hwy-M341	1966
	Noctuidae	Texas Cr. Rd.	1966
	Microlepidoptera	Osoyoos	1966
	<u>Malacosoma pluviale</u> Dyar	Victoria	1967
	<u>Melanolophia imitata</u> Wlk.	Port Renfrew	1967
		Alberni	1968
		Hazelborg	1968
	<u>Pristiphora erichsonii</u> (Hartig)	Salmo	1968
	<u>Zeiraphera destitutana</u> (Walker)	Strathnaver	1968
	<u>Ectropis crepuscularia</u> Schiff.	Kinkolith	1968
	<u>Synaxis pallulata</u> Hulst.	Hope	1968
	<u>Acleris variana</u> (Fern.)	Hope	1968
	<u>Feralia</u> sp.	Hazelton	1968
	Geometrid	S. Hazelton	1968
	Noctuid	St. Mary Lake	1968
	<u>Malacosoma disstria</u> Hbn.	Fraser Mills	1969
	<u>Malacosoma pluviale</u> Dyar	Esquimalt	1969
	<u>Melanolophia imitata</u> Wlk.	Port Alice	1969
	<u>Ectropis crepuscularia</u> Schiff.	Kitimat	1969
	<u>Choristoneura fumiferana</u> Clem.	Boston Bar	1969
	<u>Acleris variana</u> (Fern.)	Squamish	1969



TABLE 1 (Cont.)

Microorganism	Name of insect	Locality	Year
<u>VIRUS</u>			
Polyhedrosis	<u>Eupithecia annulata</u> Hulst.	Bridge Lake	1965
	<u>Malacosoma pluviale</u> Dyar	Victoria	1965
		Saanich Peninsula	1965
	<u>Acleris variana</u> (Fern.)	Hupel	1965
	<u>Stilpnotia salicis</u> (L.)	Hedley	1965
	<u>Zeiraphera pseudotsugana</u> Kft.	Lache Leune Rd.	1965
	<u>Nyctobia limitaria</u> <u>nigroangulata</u> Stkr.	Barrier R. Rd.	1965
	<u>Ectropis crepuscularia</u> Schiff.	Hot Springs Cove	1965
	<u>Pikonema dimmockii</u> (Cress.)	Tahumming River	1965
	<u>Melanolophia imitata</u> Wlk.	Port Clements-G.I.	1965
	<u>Eupithecia</u> sp.	Terrace	1965
		Cayoosh Creek	1965
	<u>Neodiprion</u> sp.	Cayoosh Creek	1965
	Tenthredinidae	Dawson Cr.	1965
		Shushwap Lake	1965
	<u>Acleris variana</u> (Fern.)	Kushana Cr. Rd.	1966
		Wilson Lake	1966
		Saddle Mtn.	1966
		Crawford Cr.	1966
		Vernon	1966
		Cherryville-M10	1966
		Keen Cr.-M5	1966
	<u>Malacosoma pluviale</u> Dyar	Victoria	1966
	<u>Vanessa cardui</u> L.	Enderby	1966
	<u>Neophasia menapia</u> Feld.	Copper Canyon	1966
	<u>Dioryctria</u> sp.	Kelowna	1966
	<u>Malacosoma pluviale</u> Dyar	Victoria	1967
	<u>Acleris variana</u> (Fern.)	Harrison Lake	1967
		Wilson Lake Rd-M3	1967
		South Pass Cr.	1967
	<u>Neophasia menapia</u> Feld.	Summerside	1968
	Chemanius	1968	
<u>Choristoneura fumiferana</u> (Clem)	Boston Bar	1968	
	Hope	1968	
<u>Tetropium cinnamopterum</u> Kirby	Prince George	1968	
<u>Nymphalis antiopa</u> L.	Vernon	1968	
<u>Acleris variana</u> (Fern.)	Kitchener	1968	
	Hope	1968	
	Crawford Bay	1968	
<u>Papilio daunus</u> Bdv.	Vernon	1968	
<u>Malacosoma disstria</u> Hbn.	Victoria	1968	
	Sydney Is.	1968	
<u>Malacosoma pluviale</u> Dyar	Sydney Is.	1968	

TABLE 1 (Cont.)

Microorganism	Name of insect	Locality	Year
<u>VIRUS (Cont.)</u>			
Polyhedrosis (Cont.)	<u>Halisidota argentata</u> Pack.	Mill Bay	1968
	<u>Pissodes</u> sp.	Clinton	1968
	<u>Malacosoma disstria</u> Hbn.	Fraser Mills	1969
		Port Mann	1969
		New Westminster	1969
	<u>Malacosoma pluviale</u> Dyar	Galiano Is.	1969
	<u>Melanolophia imitata</u> Wlk.	Port Alice	1969
	<u>Orgyia pseudotsugata</u> McD.	Esquimalt	1969
		Victoria	1969
	<u>Ectropis crepuscularia</u> Schiff.	Kitimat	1969
	<u>Stilpnotia salicis</u> (L.)	Slocum	1969
	<u>Hyphantria cunea</u> (Drury)	Irish Creek	1969
	<u>Choristoneura fumiferana</u> (Clem)	Alaska Hwy-M514	1969
	Granulosis	<u>Hyphantria cunea</u> (Drury)	Irish Creek

TABLE 1 (Cont.)

Microorganism	Name of Insect	Locality	Year	
<u>PROTOZOA</u>				
Microsporidia	<u>Malacosoma pluviale</u> Dyar	Saanich	1965	
	<u>Melanolophia imitata</u> Wlk.	Vernon	1965	
	<u>Eupithecia filmata</u> Pears	Chetwynd	1965	
	<u>Orthosia hibisci</u> Gn.	Fort St. James	1965	
	<u>Nyctobia limitaria</u> <u>nigroangulata</u> Stkr.	Barner Cr.	1965	
	<u>Lambdina fiscellaria</u> <u>lugubrosa</u> Hulst	Vernon	1965	
	<u>Neophasia menapia</u> (Feld.)	Vernon	1965	
	<u>Eupithecia</u> sp.	North Galiano Is.	1965	
	<u>Syngrapha</u> sp.	Horsefly	1965	
	Geometridae	Kitwanga	1965	
		<u>Lambdina fiscellaria</u> <u>lugubrosa</u> Hulst	Rolley Lake	1966
		<u>Lithophane lepida</u> (Lintner)	Princeton	1966
		<u>Acleris variana</u> (Fern.)	Saddle Mt.	1966
			Nelson	1966
			Cusson Cr. Rd.	1966
		<u>Pristiphora erichsonii</u> (Hartwig)	Thrum	1966
			Passmore	1966
			Lemon Cr.	1966
		<u>Nyctobia limitaria</u> <u>nigroangulata</u> Stkr.	Bridge Lake Rd.	1966
			Porthill	1966
			Cinema	1966
		<u>Zeiraphera</u> sp.	Lavington	1966
			Lumby	1966
		<u>Eupithecia</u> sp.	Alaska Hwy-M100	1966
		<u>Xylotype</u> sp.	Vanderhoff	1966
		<u>Eupisilia</u> sp.	Dawson Cr.	1966
		Noctuidae	Hansard	1966
		Tentredinidae	Summit Lk.	1966
		Tentredinidae	Tata Lk.	1966
		Olethreutidae	Yakk	1966
		<u>Malacosoma Pluviale</u> (Dyar)	Victoria	1967
		Geomedridae	Cinema	1967
		<u>Dendroctonus obesus</u> (Mann.)	Victoria	1968
		<u>Pikonema dimmockii</u> (Cress.)	Sayward	1968
		<u>Zeiraphera destitutana</u> (Walker)	Ferndale	1968
		<u>Lithophane lepida</u> Lint.	150 Mile House	1968
	<u>Pikonema alaskensis</u> (Roh.)	Vernon	1968	
	<u>Acleris variana</u> (Fern)	Crawford Bay	1968	
		Hope	1968	

TABLE 1 (Cont.)

Microorganism	Name of insect	Locality	Year	
<u>PROTOZOA (Cont.)</u>				
Microsporidia (Cont.)	<u>Choristoneura fumiferana</u> (Clem.)	Canal flats	1968	
		Boston Bar	1968	
	<u>Halisidota argentata</u> Pack.	Mill Bay	1968	
	<u>Malacosoma disstria</u> Hbn.	Victoria	1968	
	Noctuidae		Ferndale	1968
			Francis Lake	1968
			Ross Lake	1968
		<u>Malacosoma disstria</u> Hbn.	Port Mann	1969
		<u>Malacosoma pluviale</u> Dyar	Galiano Is.	1969
		<u>Orgyia pseudotsugata</u> Md.	Esquimalt	1969
		<u>Hyphantria cunea</u> (Drury)	Irish Creek	1969
		<u>Melanolophia imitata</u> Wlk.	Port Alice	1969
		<u>Leucobrephos brephoides</u> Wlk.	Narcosti Crk.	1969
		<u>Zeiraphera</u> sp.	Tofino	1969
		<u>Choristoneura fumiferana</u> (Clem)	Alaska Hwy-M514	1969

TABLE 1 (Cont.)

Microorganism	Name of insect	Locality	Year	
<u>BACTERIA</u>				
<u>Bacillus thuringiensis</u> var. <u>galleriae</u>	<u>Acronicta grisea</u> Wlk.	Cache Creek	1965	
	<u>Neophasia menapia</u> (Feld.)	O.K. Landing	1965	
	<u>Pristiphora erichsonii</u> (Hartig)	Perry Siding	1965	
	<u>Vanessa cardui</u> L.	Enderby	1966	
	<u>Malacosoma pluviale</u> Dyar	Victoria	1967	
<u>Bacillus thuringiensis</u> Serotype I	<u>Pristiphora erichsonii</u> (Hartig)	Passmore	1965	
	<u>Eupithecia annulata</u> Hulst.	Osprey Lake	1965	
	<u>Bacillus cereus</u>	<u>Lambdina fiscellaria</u> <u>lugubrosa</u> Hulst	Rolley Lake	1965
		<u>Orthosia hibisci</u> Gn.	Ashcroft	1965
	<u>Bacillus cereus</u>	<u>Melanolophia imitata</u> Wlk.	B.C. Interior	1965
		<u>Eupithecia</u> sp.	Nelson	1965
	<u>Bacillus brevis</u>	<u>Melanolophia imitata</u> Wlk.	B.C. Interior	1965
<u>Bacillus</u> sp.	<u>Epicnaptera americana</u> Harr.	Gibson Landing	1965	
	<u>Dioryctria cambiicola</u> Dyar	Winfield	1965	
	<u>Epirritta autumnata omissa</u> Harris	Dease Lake Rd.	1965	
		<u>Lygris destinata</u> Moesh.	Cassiar Rd.	1965
	<u>Malacosoma pluviale</u> Dyar	Victoria	1965	
	<u>Melanolophia imitata</u> Wlk.	Bamfield	1965	
	<u>Pristiphora erichsonii</u> (Hartig)	Salmo	1965	
		Harrop-Roctor	1965	
	<u>Lambdina fiscellaria</u> <u>lugubrosa</u> Hulst	Lund	1965	
	Pamphiliidae	Pitney Lake	1965	
	Tenthredinidae	Chetwynd	1965	
	Microlepidoptera	Clinton	1965	
	<u>Malacosoma pluviale</u> Dyar	Victoria	1966	
	<u>Lambdina fiscellaria</u> <u>lugubrosa</u> Hulst.	Rolley Lake	1966	
		<u>Nyctobia limitaria</u> <u>nigroangulata</u> Stkr.	Westwold	1966
	<u>Monochamus maculosis</u> Hald.	Alexandria	1966	
	<u>Melanolophia imitata</u> Wlk.	Stuart	1966	
	<u>Zeiraphera</u> sp.	Christina Mtn.	1966	
	Geometridae	Summit	1966	
	<u>Ryacionia buoliana</u> Schiff.	Sardis	1967	
<u>Acleris variana</u> (Fern.)	Taghum	1967		

TABLE 1 (Cont.)

Microorganism	Name of insect	Locality	Year
<u>BACTERIA (Cont.)</u>			
<u>Bacillus</u> sp. (Cont.)	<u>Lambdina fiscellaria</u>	Bella Coola	1968
	<u>lugubrosa</u> Hulst.	Hope	1968
	<u>Melanolophia imitata</u> Wlk.	Gold River	1968
		Hazelborg	1968
		Zeballos	1968
		Alberni	1968
		Kyaquot	1968
	<u>Feralia jocosa</u> Gn.	Hazelton	1968
	<u>Tolype dayi</u> Blkmre.	Oliver	1968
	<u>Halisidota maculata</u> (Harr.)	Prince Rupert	1968
	<u>Malacosoma pluviale</u> Dyar	Sydney Is.	1968
	<u>Hemichoa crocea</u> (Fourc.)	Guskatla Camp	1968
	Noctuidae	Francis Lake	1968
	<u>Malacosoma disstria</u> Hbn.	Port Mann	1969
		Fraser Mills	1969
		New Westminster	1969
	<u>Melanolophia imitata</u> Wlk.	Alberni	1969
	<u>Hyphantria cunea</u> (Drury)	Irish Creek	1969
	<u>Stilpnotia salicis</u> (L.)	Slocum	1969
	<u>Epirrita autumnata</u> Harris	Woodfibre	1969
	<u>Leucobrephos brephoides</u> Wlk.	Narcosti Crk.	1969
	<u>Pikonema dimmockii</u> (Cres.)	Beaverdell	1969
	<u>Disonycha alternata</u> Ill.	Fort Nelson	1969
	Noctuidae	Cinema	1969
	Tenthredinidae	Fort St. John	1969

TABLE 2

A summary of host specimens infected by various pathogens<sup>1</sup>

Host species	Pathogens
HOMOPTERA	
<u>Adelges piceae</u> (Ratz.)	F
LEPITOPTERA	
<u>Eupithecia filmata</u> Peavs.	F, M
<u>Eupithecia annulata</u> Hulst.	F, P
<u>Eupithecia</u> sp.	F, M, P, B
<u>Lambdina fiscellaria somnaria</u> Hulst.	F
<u>Lambdina fiscellaria lugubrosa</u> Hulst.	F, M, B
<u>Melanolophia imitata</u> Wlk.	F, M, P, B
<u>Malacosoma pluviale</u> Dyar	F, M, P, B
<u>Malacosoma disstria</u> Hbn.	F, M, P, B
<u>Syngrapha rectangula margenta</u> Ott.	F
<u>Syngrapha</u> sp.	M
<u>Cephalicia</u> sp.	F
<u>Petrova albicapitana</u> (Busck)	F
<u>Neophasia menapia</u> Feld.	F, M, P, B
<u>Operophtera bruceata</u> Hulst.	F
<u>Ectropis crepuscularia</u> Schiff.	F, P
<u>Zeiraphera destitutana</u> Walker	F, M
<u>Zeiraphera pseudotsugana</u> Kfl.	P
<u>Zeiraphera</u> sp.	F, M, B
<u>Nyctobia limitaria nigromaculata</u> Stkr.	F, M, P, B
<u>Pseudohazia eglanterina</u> (Bud)	F
<u>Choristoneura fumiferana</u> (Clem.)	F, M, P
<u>Acleris variana</u> (Fern.)	F, M, P, B
<u>Epinotia</u> sp.	F
<u>Synaxis pallulata</u> Hulst.	F
<u>Feralia jocosa</u> (Gn)	B
<u>Feralia</u> sp.	F
<u>Stilpnotia salicis</u> (L.)	P, B
<u>Vanessa cardui</u> L.	P, B
<u>Dioryctria cambiicola</u> Dyar	B
<u>Dioryctria</u> sp.	P
<u>Nymphalis antiopa</u> L.	P
<u>Papilio daunus</u> Bud.	P
<u>Halisidota argentata</u> Pack.	M, P
<u>Halisidota maculata</u> (Harr.)	B
<u>Orgyia pseudotsugata</u> McD.	M, P
<u>Hyphantria cunea</u> Drury	M, P, B, G
<u>Orthosia hibisci</u> (Gn.)	M, B
<u>Lithophana lepida</u> Linther	M
<u>Xylotype</u> sp.	M
<u>Eupisilia</u> sp.	M
<u>Leucobrepbos brephoides</u> Wlk.	M, B
<u>Acronicta grisea</u> Wlk.	B

TABLE 2 (Cont.)

Host species	Pathogens
LEPIDOPTERA (Cont.)	
<u>Epicnaptera americana</u> (Harr.)	
<u>Epicnaptera</u> sp.	B
<u>Epirrita autumnata</u> Harris	B
<u>Epirrita autumnata omissa</u> Harris	B
<u>Lygris destinata</u> Moesh.	B
<u>Ryacionia buoliana</u> Schiff.	B
<u>Tolype daji</u> Blkmre.	B
<u>Disonycha alternata</u> Ill.	B
Olethreutidae	M
Pamphilidae	B
Noctuidae	F, M, B
Microlepidoptera	F, B
Tortricidae	F
Geometridae	F, M, B
HYMENOPTERA	
<u>Pikonoma dimmockii</u> (Cress.)	M, P, B
<u>Pikonema alaskensis</u> (Roh.)	M
<u>Pikonema</u> sp.	F
<u>Pristiphora erichsonii</u> (Hartig)	F, M, B
<u>Hemichroa crucea</u> (Fourc.)	B
Neodiprion species	P
Tentredinidae	F, M, P, B
COLEOPTERA	
<u>Dendroctonus obesus</u> (Mann.)	F, M
<u>Monochamus maculosus</u> Hald.	B
<u>Tetropium cinnamopterum</u> Kirby	P
<u>Pissoides</u> sp.	P

<sup>1</sup> F = fungus; M = microsporidia; P = polyhedrosis virus; B = bacilli;  
G = granulosis virus.



TABLE 3  
Annual incidence of diseases in populations of  
British Columbia defoliators, 1947-1969.

Insect species	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
<i>L. f. succinaria</i>	3	3 FPB	3 FTD	2	2	1	1	1	1	1	1	2	2	2	3	1	1	1	1	1	1	1	1
<i>L. f. lugubrosa</i>	3 FPB	1	1 FP	1 F	1 FPB	2	2 FTD	2	2	1	1	2	2	2	2	2	2	2	1	2	1	1	2
<i>M. latata</i>	3	2	2	2 FPB	2	2	2	1	1	1	1	2	2	2	1	1	1	2	2	3	3	3	3
<i>M. pluviale</i>	3	3	3	3	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
<i>M. disticta</i>	1 B	1	3	1	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3
<i>A. variata</i>	1	1	1	2	2	2	3	2	2	2	3	2	3*	1	1	2	1	1	2	2	3	2	2
<i>O. pseudotsugata</i>	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>H. cunea</i>	1	1	2	2	1	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Choristoneura</i> sp.	1	2	3	3	2	2	2	2	2	2	2	3	3	3	3	3	3	2	2	2	2	2	1
<i>S. malicola</i>	1	1	2	1	1	1	1	2	2	2	2	2	2	1	2	2	2	2	2	2	2	1	1
<i>V. carvut</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>N. phantasmaria</i>	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	2	1	1	1
<i>N. denipila</i>	1	1	1	1	1	1	1	1	1	1	1	1	2	3	3*	3	3	2	2	2	1	1	1
<i>H. antiopea</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>H. argentata</i>	1	1	1	1	1	1	1	2	2	1	1	1	1	2	2	2	1	1	1	1	1	1	1
<i>O. hibiscel</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>E. crepuscularia</i>	1	1	1	1	1	1	3	2	1	1	1	1	2	3	2	1	1	2	1	1	2	2	2
<i>C. diviata</i>	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1
<i>E. vancouverensis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1

1, 2, 3 represents high, moderate and low incidence of insects, respectively.

F, P, B, G, B = fungus, polyhedrosis virus, microsporidiosis, granulosis virus, and bacteria, respectively

\* Aerial application of DDT.

### Acknowledgements

We thank the late Dr. E. A. Steinhaus, University of California for preparing Figures 5, 8, 9 and 10, and Mr. J. M. Burke, I.P.R.I., Sault Ste. Marie for preparing Figures 4 and 13.

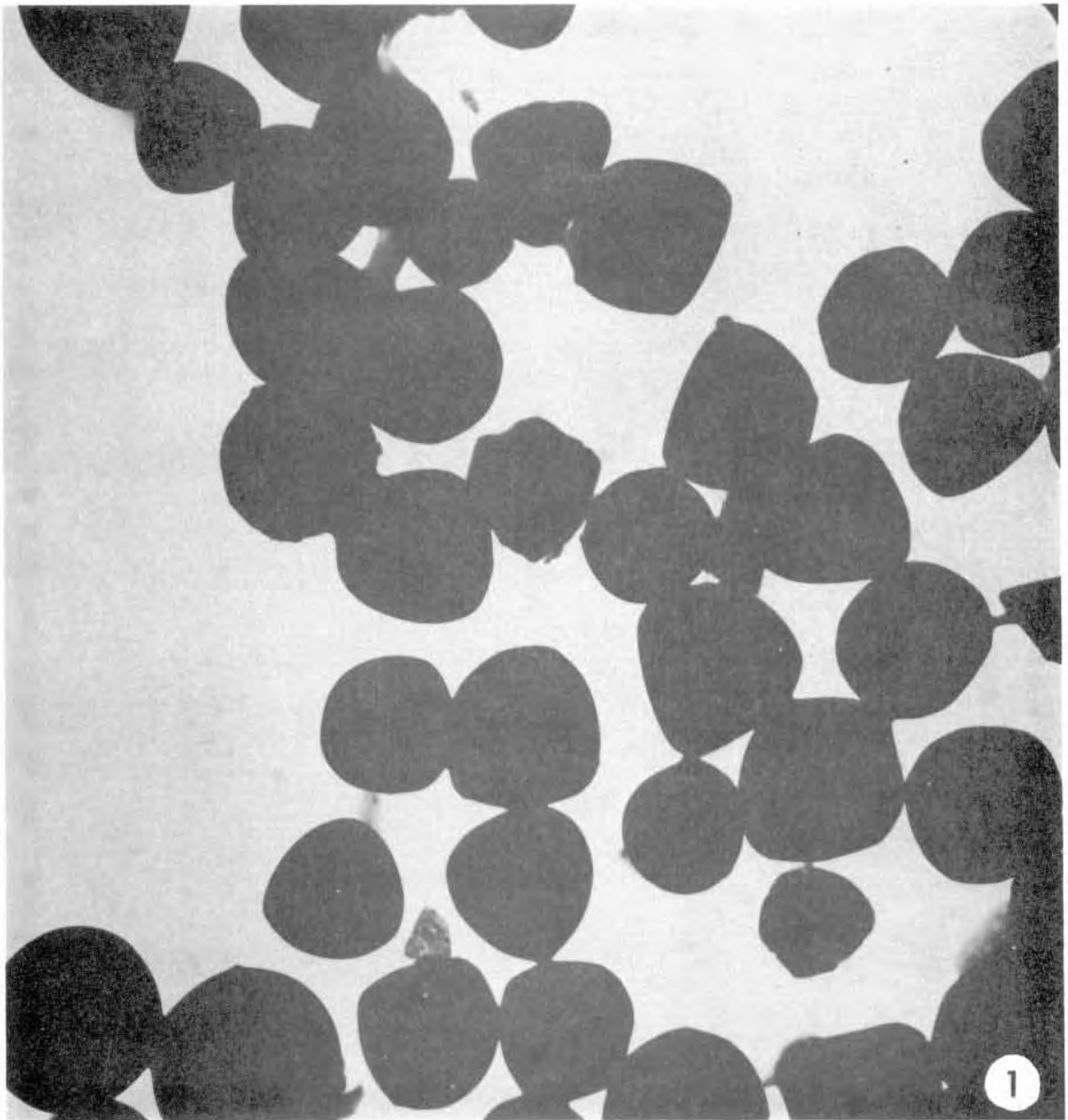
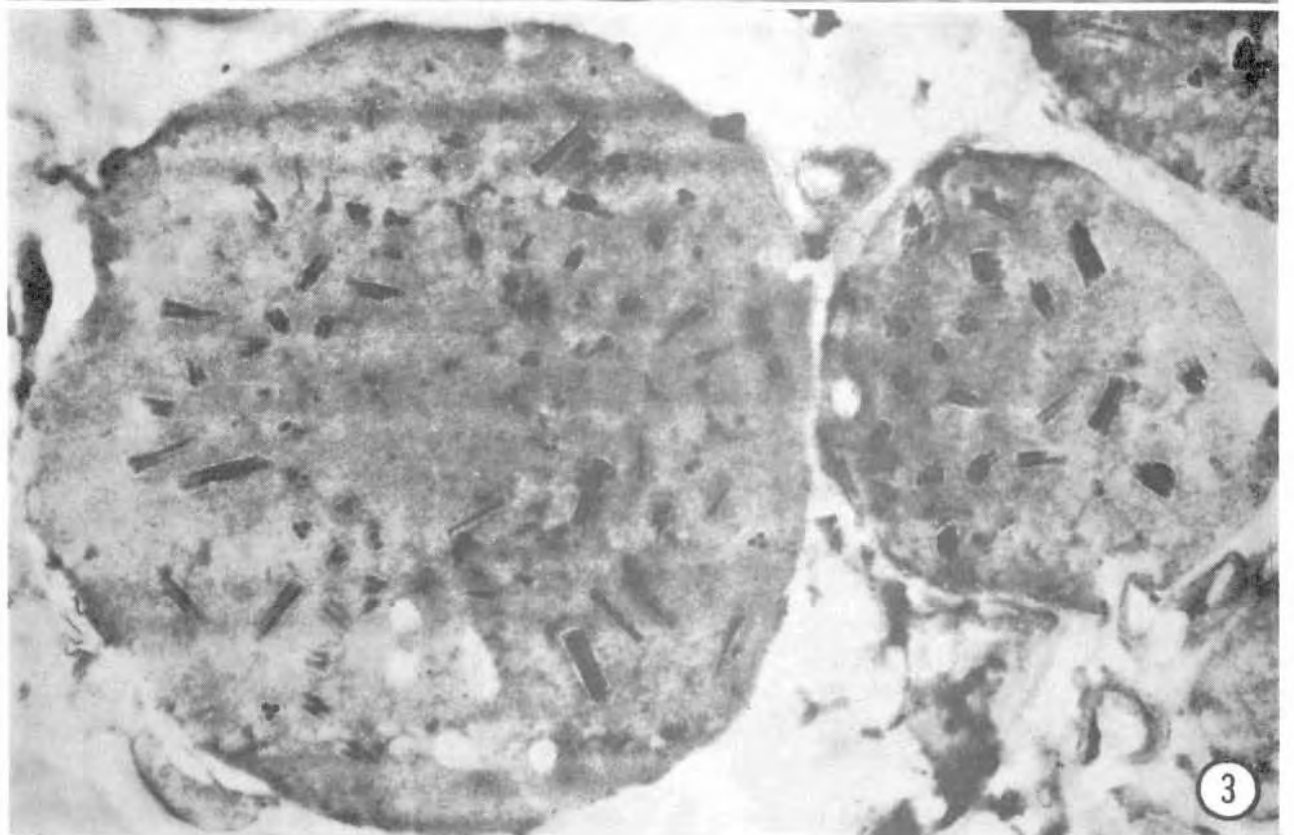
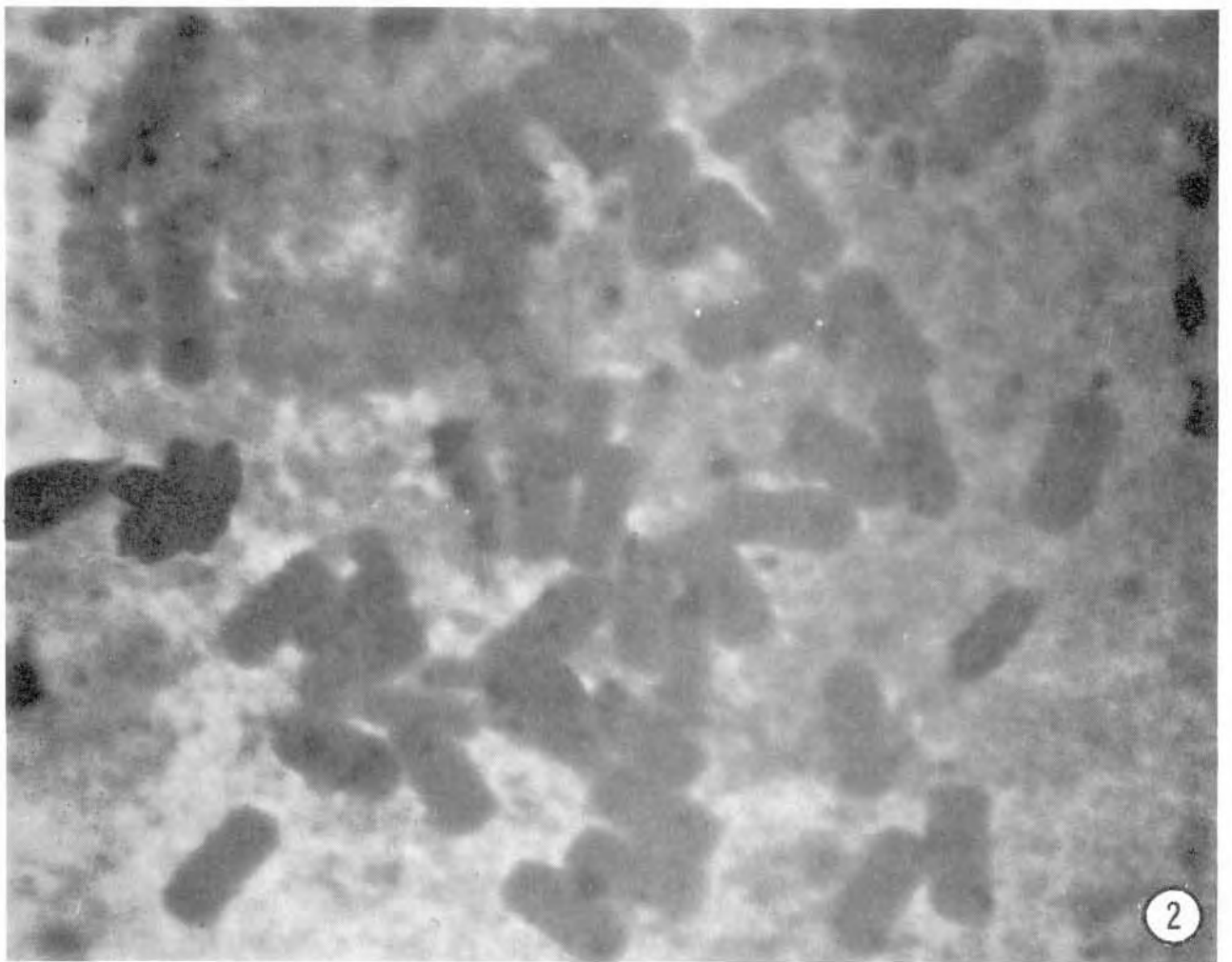
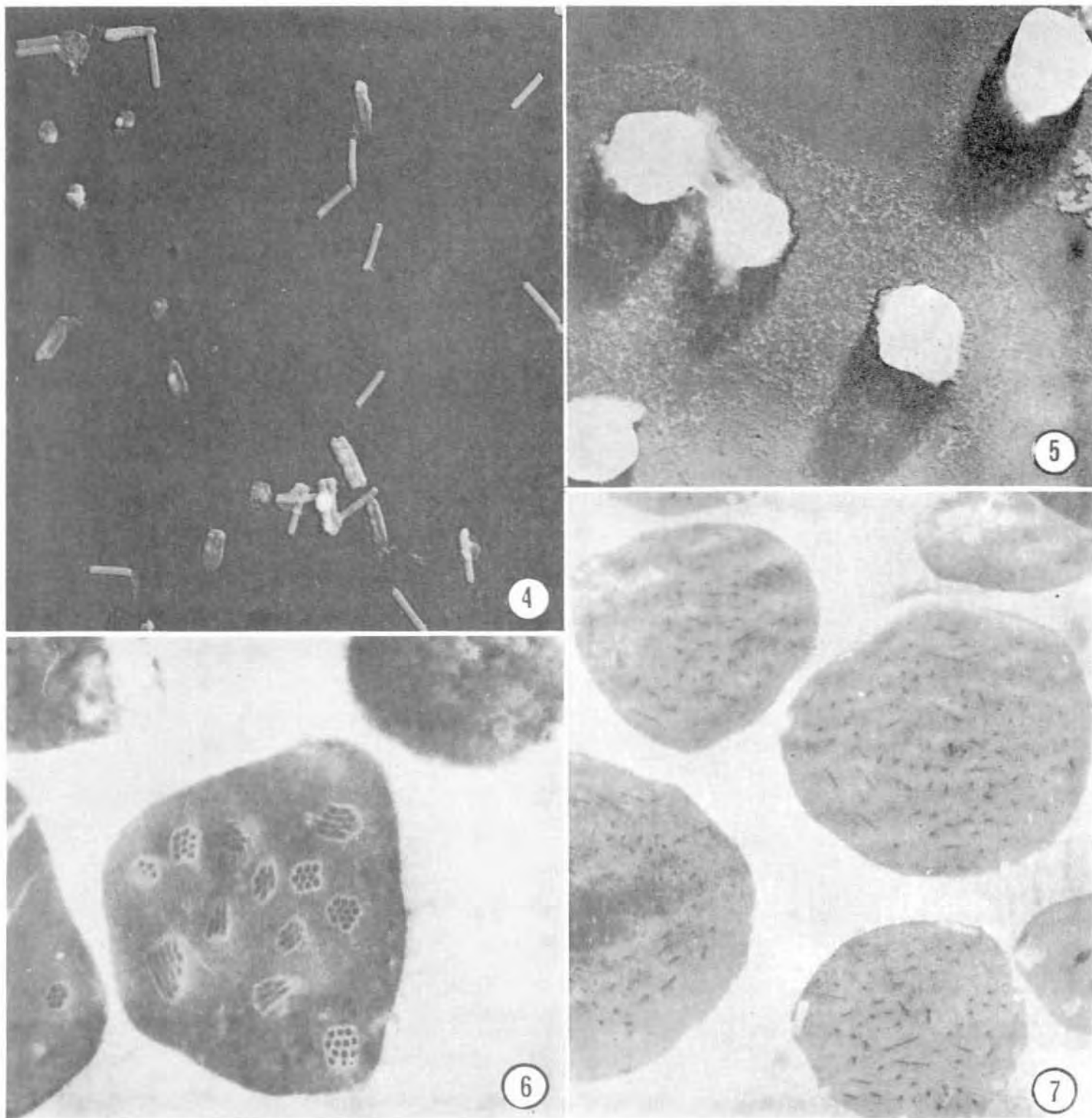


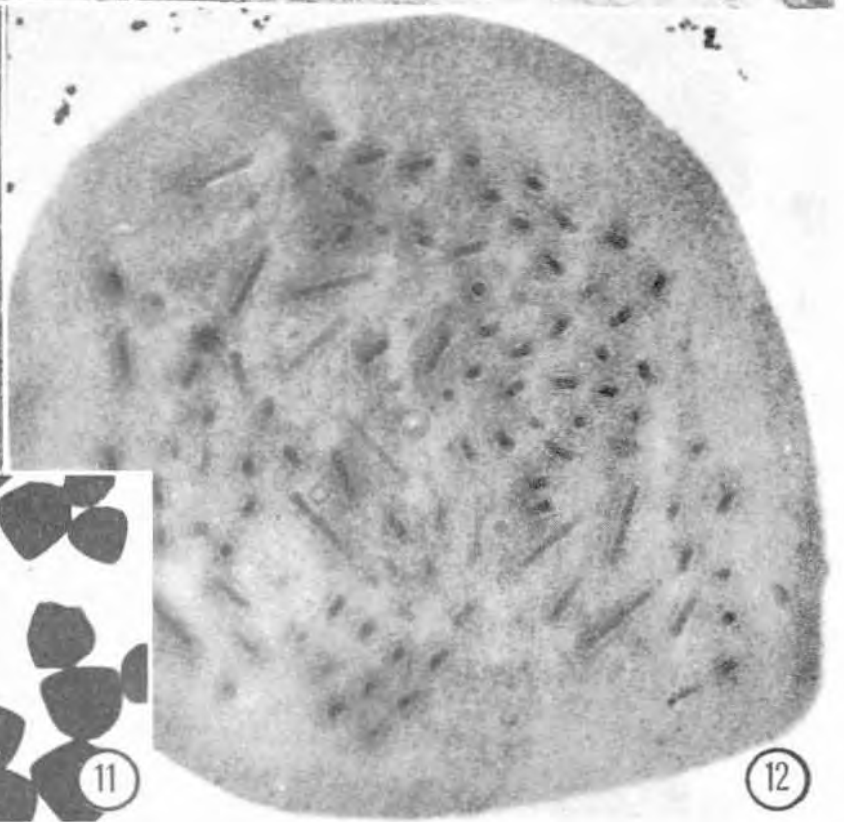
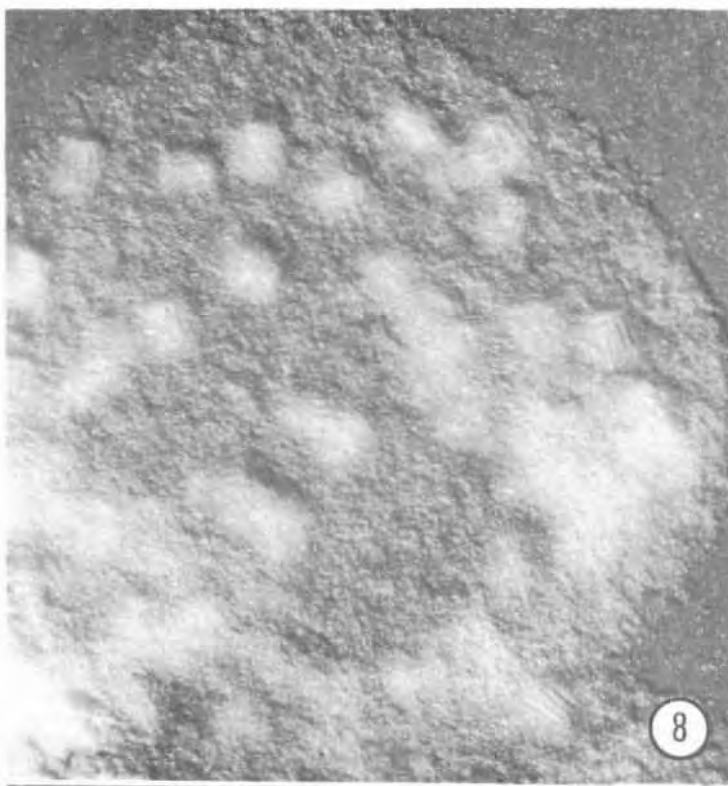
Fig. 1. Electronphotomicrograph of nuclear polyhedra of Lambdina fiscellaria somniaria, approx. 15,000X.



Figs. 2-3. Electronphotomicrographs of nuclear polyhedrosis virus of *L. f. somnaria* showing; 2. bundles of virus rods following partial dissolution of polyhedral protein by weak alkali, approx. 15,000X; 3. sectioned polyhedral bodies revealing virus occurring singly or in bundles of from 2-3 particles, approx. 21,000X.



Figs. 4-7. Electronphotomicrographs of 4. isolated virus rods of L.f. somnaria nuclear polyhedrosis, approx. 25,000X; 5. nuclear polyhedra of Orgyia pseudotsugata, approx. 7,500X; 6. and 7. sectioned polyhedral bodies of O. pseudotsugata showing virus bundles of up to 13 particles and singly occurring particles, approx. 38,000X and 25,000X, respectively.



singly occurring particles, approx. 38,000X and 25,000X, respectively.  
 Figs. 8-12. Electronphotomicrographs of 8. *O. pseudotsugata* virus bundles in partially dissolved polyhedral protein, approx. 18,800X; 9. free virus bundles of *O. pseudotsugata*, approx. 20,500X; 10. free virus particles of *O. pseudotsugata*, approx. 25,000X; 11. nuclear polyhedra of *Ectropis crepuscularia*, approx. 6,400X; 12. a typical *E. crepuscularia* polyhedron sectioned to reveal the virus particles occurring singly, approx. 48,000X.

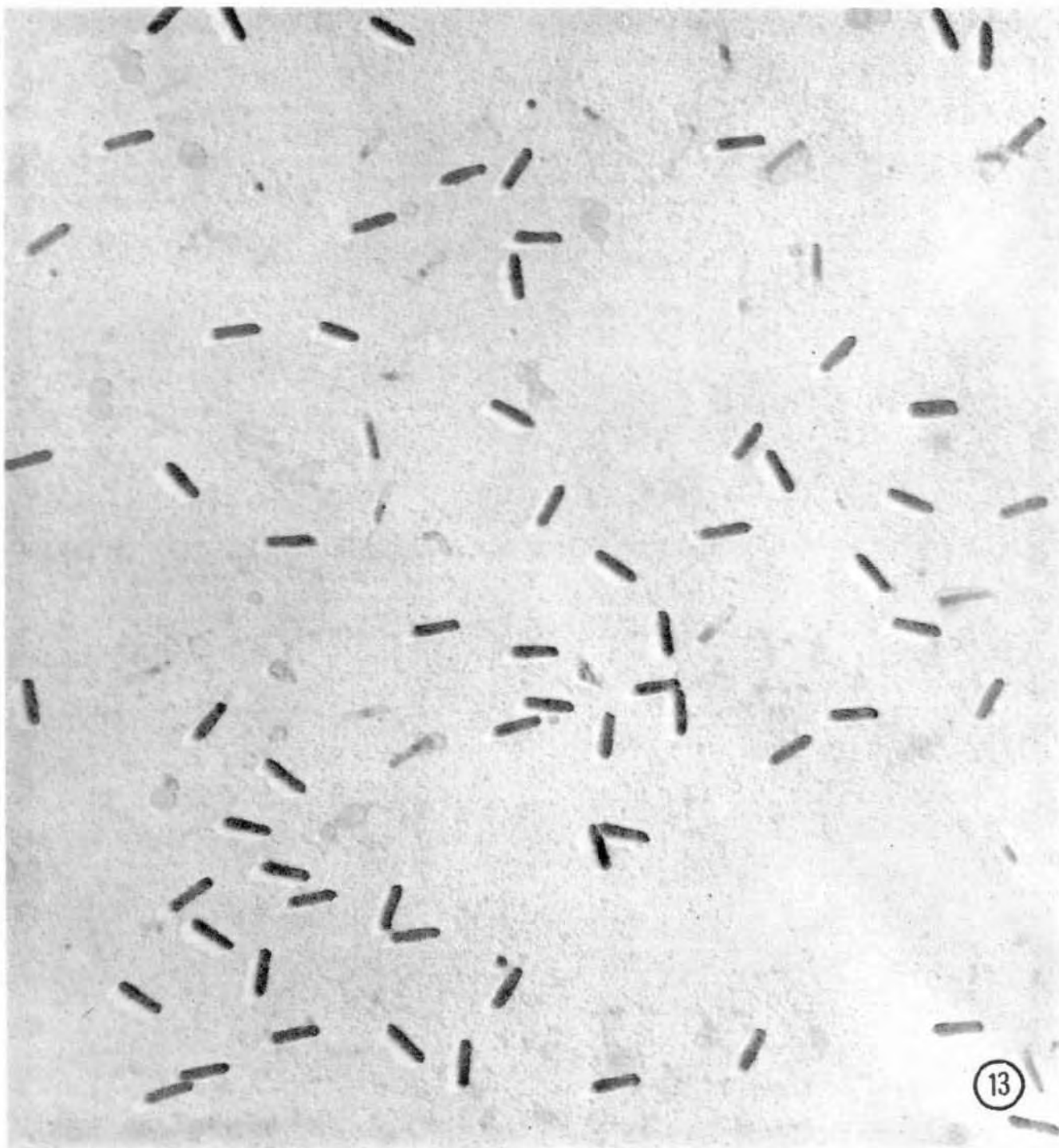
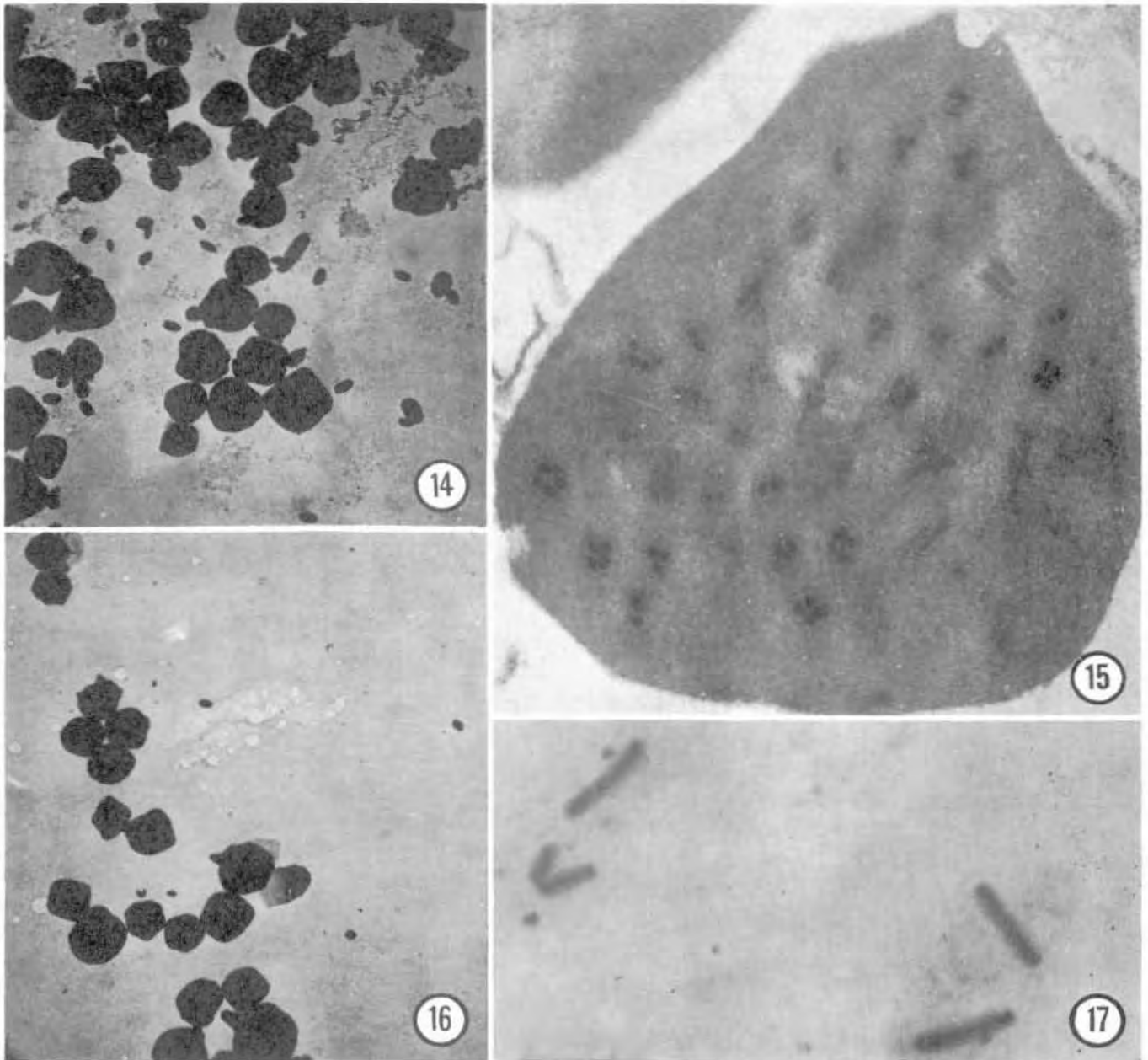
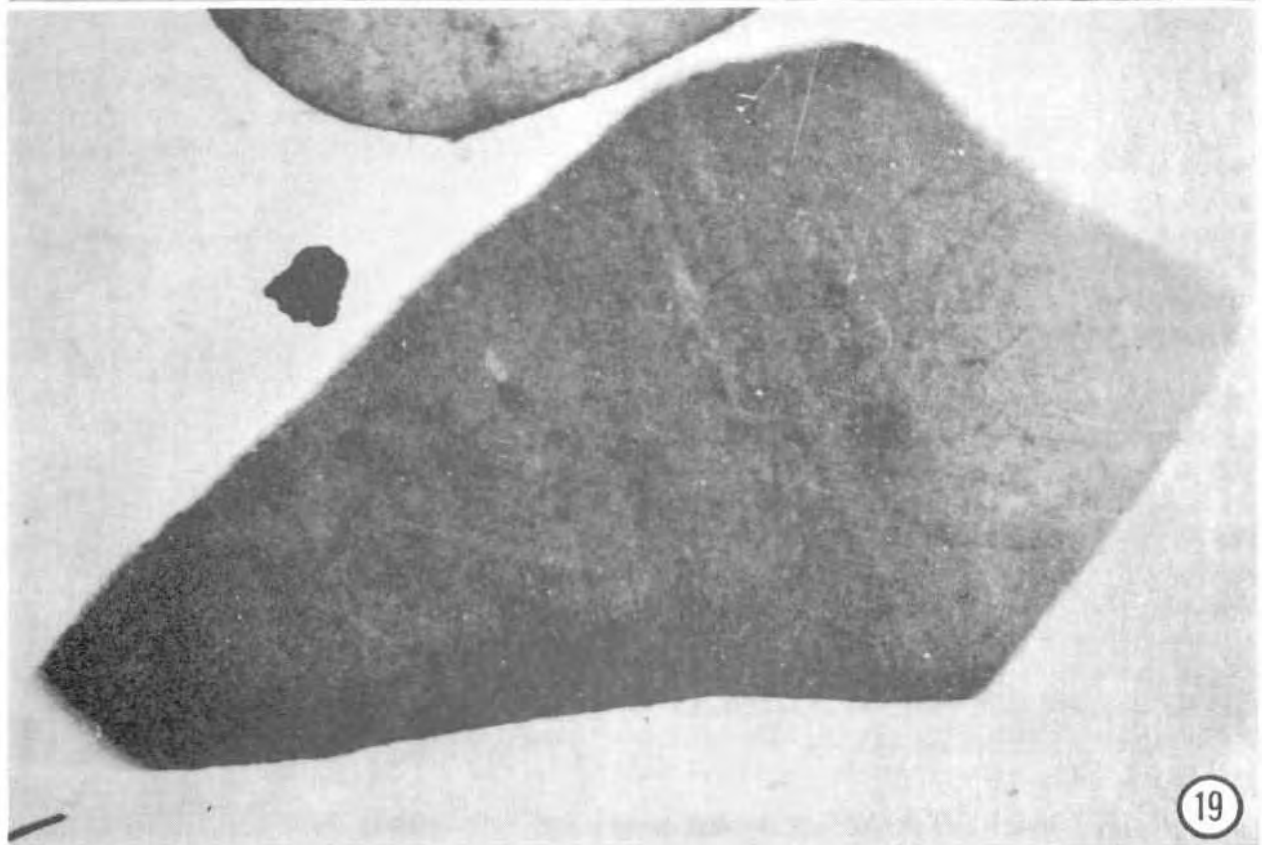
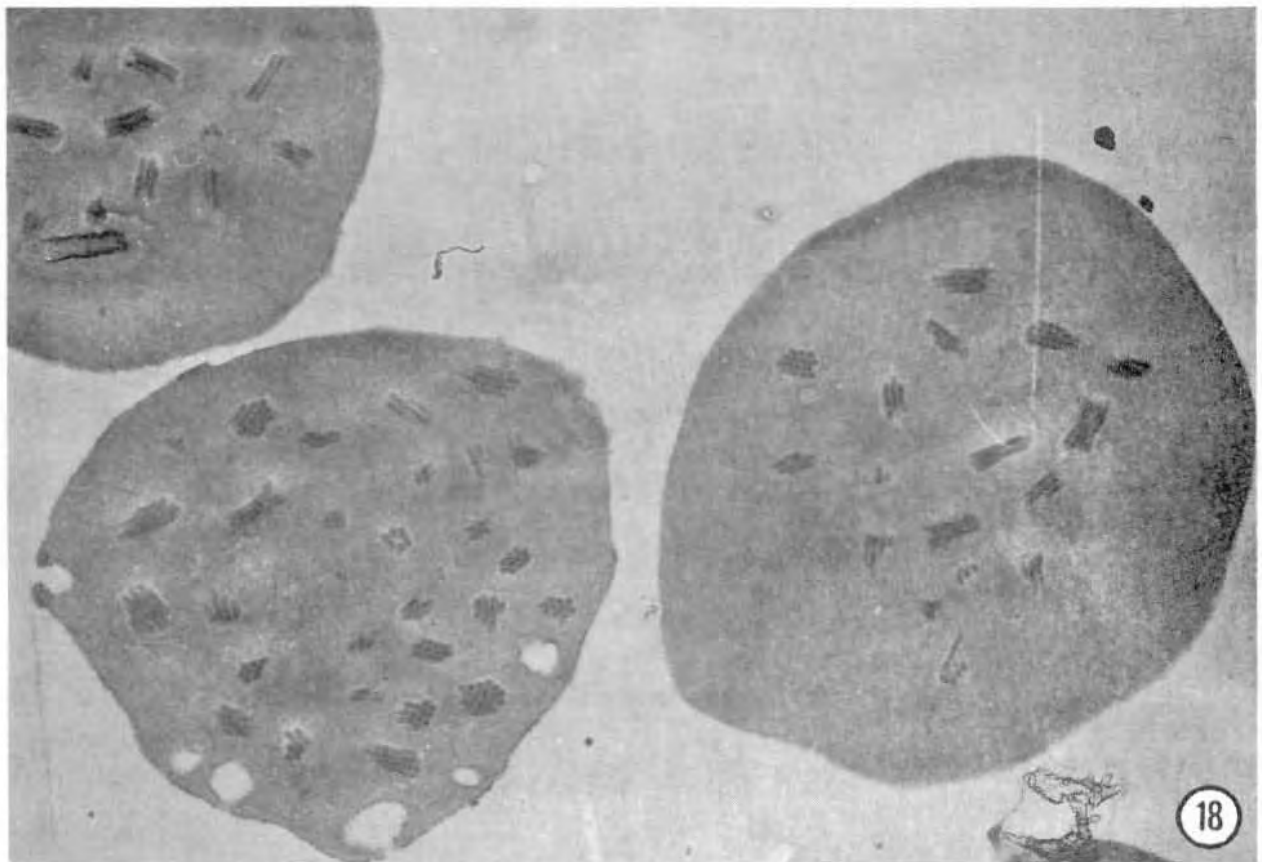


Fig. 13. Electronphotomicrograph of free virus particles of *E. crepuscularia*, approx. 25,000X.



Figs. 14-17. Electronphotomicrographs of 14. nuclear polyhedra of Nypetia phantasmaria (small dark spots are bacteria), approx. 4,400X; 15. a typical polyhedron of N. phantasmaria sectioned to reveal virus bundles of from 2-4 particles, approx. 36,000X; 16. nuclear polyhedra of Malacosoma pluviale, approx. 4,760X; 17. free virus particles of M. pluviale, approx. 50,000X.





Figs. 18-19. Electronmicrographs of nuclear polyhedrosis virus of Locusta flucellaria lugubrosa showing: 18. polyhedra sectioned to reveal bundles of virus containing from 2-11 particles, approx. 36,800X; 19. section of an inclusion body which characteristically occurs in cytoplasm of the fatbody cells infected with this virus. The body appears to be a protein crystal without any recognizable internal structure. It stains deeply with Naphthol Yellow S indicating the presence of lysine, arginine and histidine, approx. 46,700X.

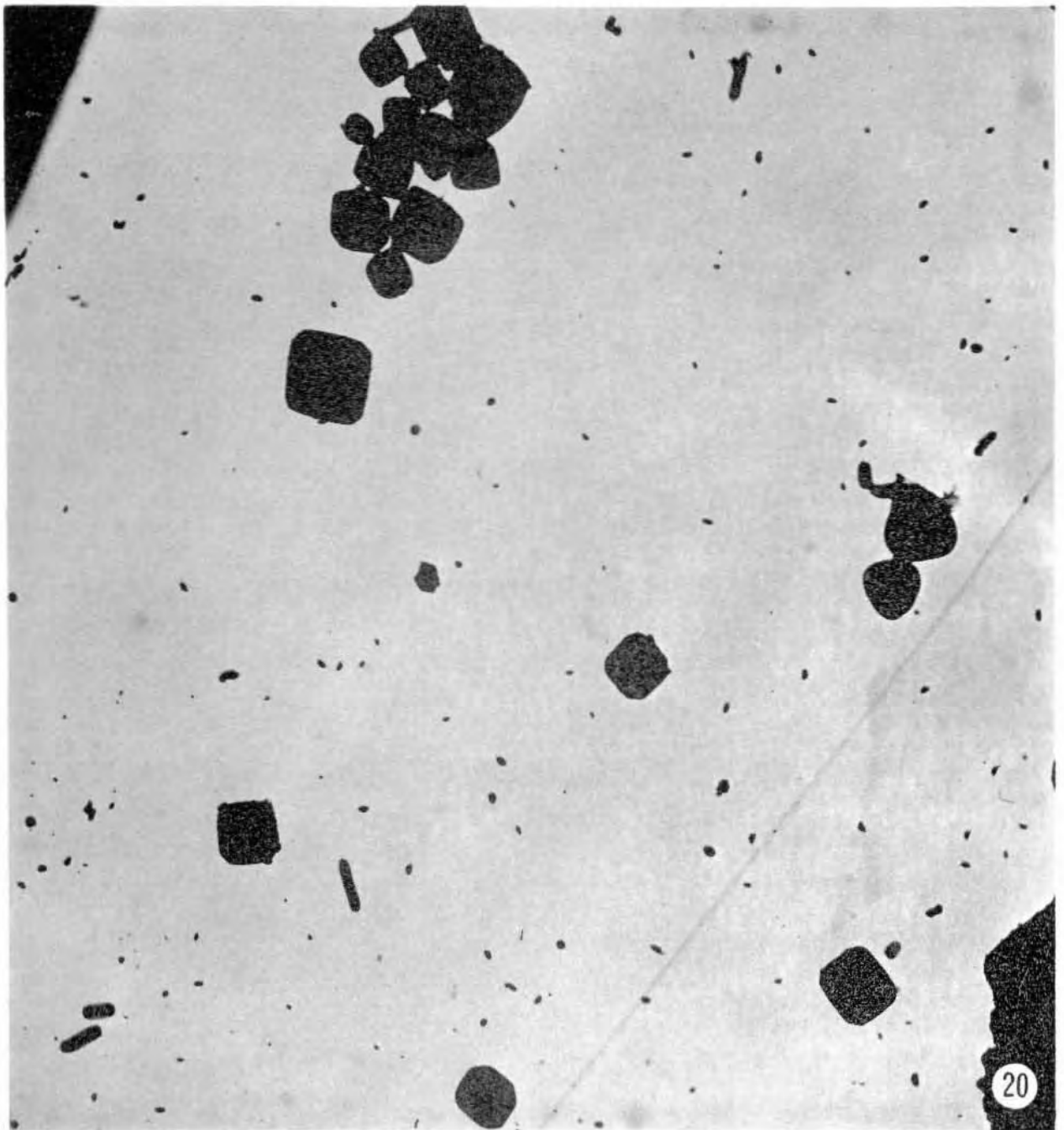
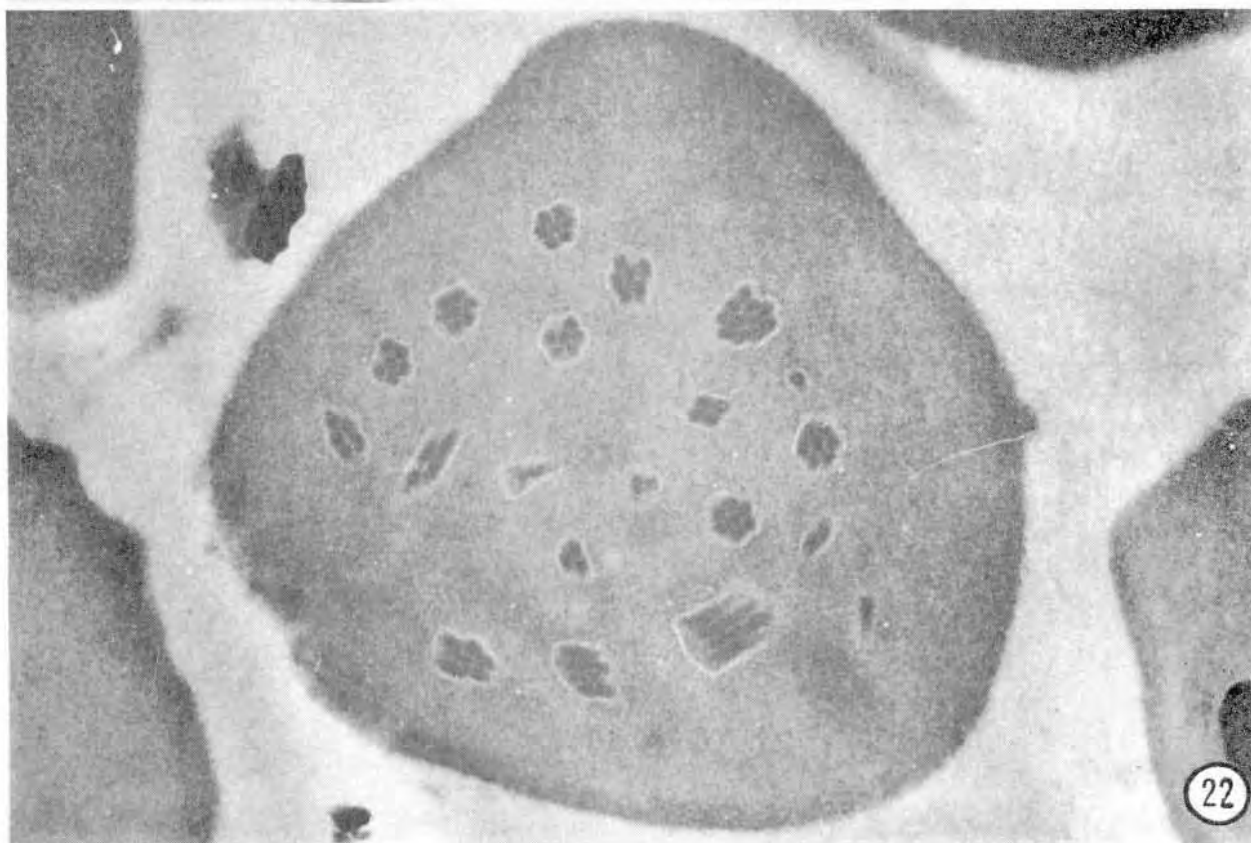
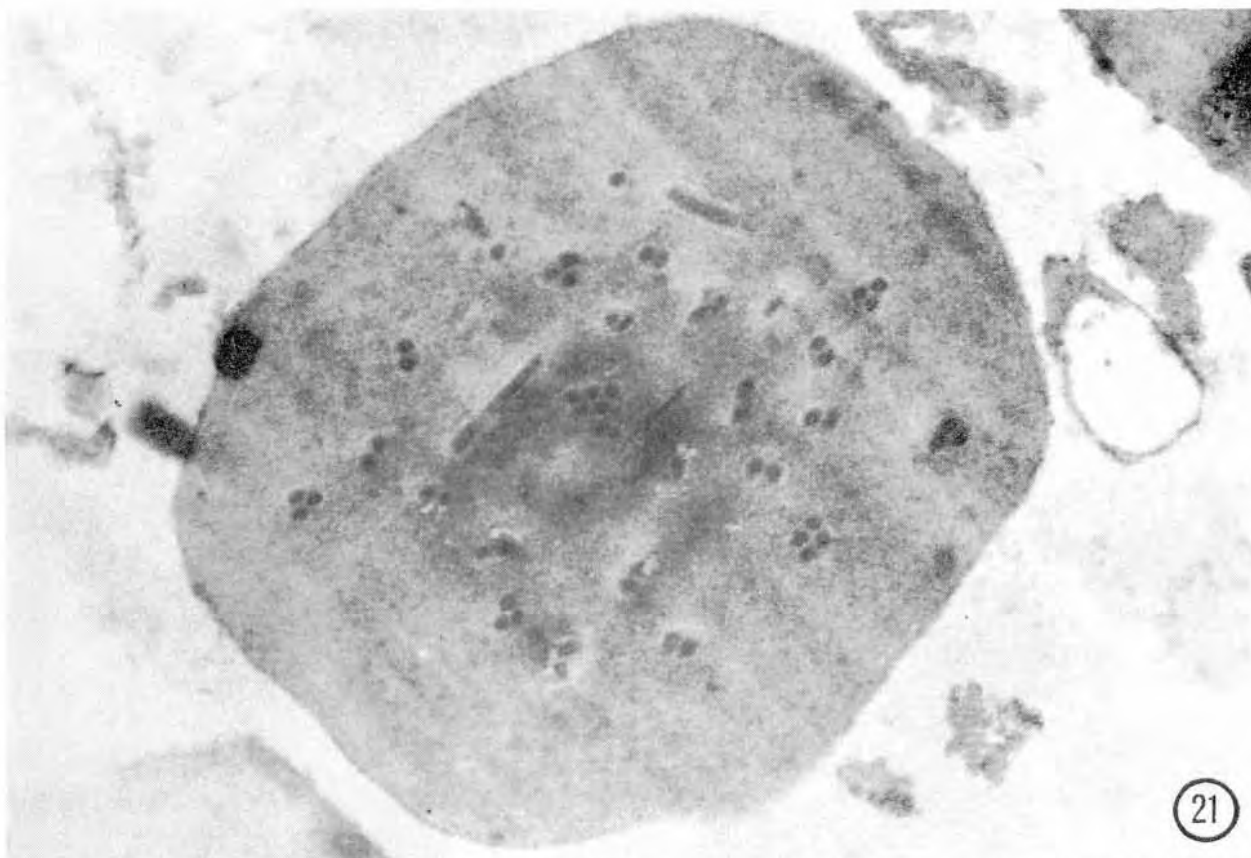
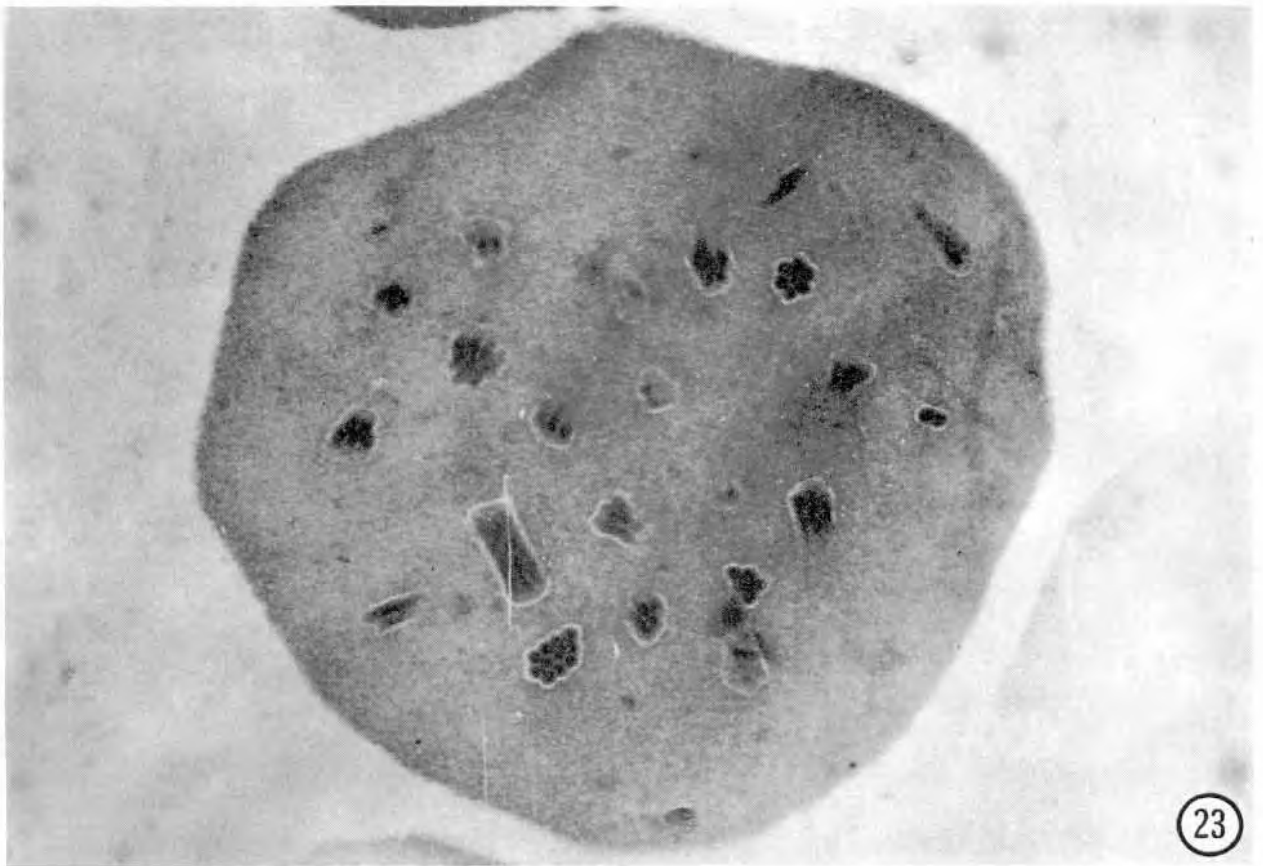


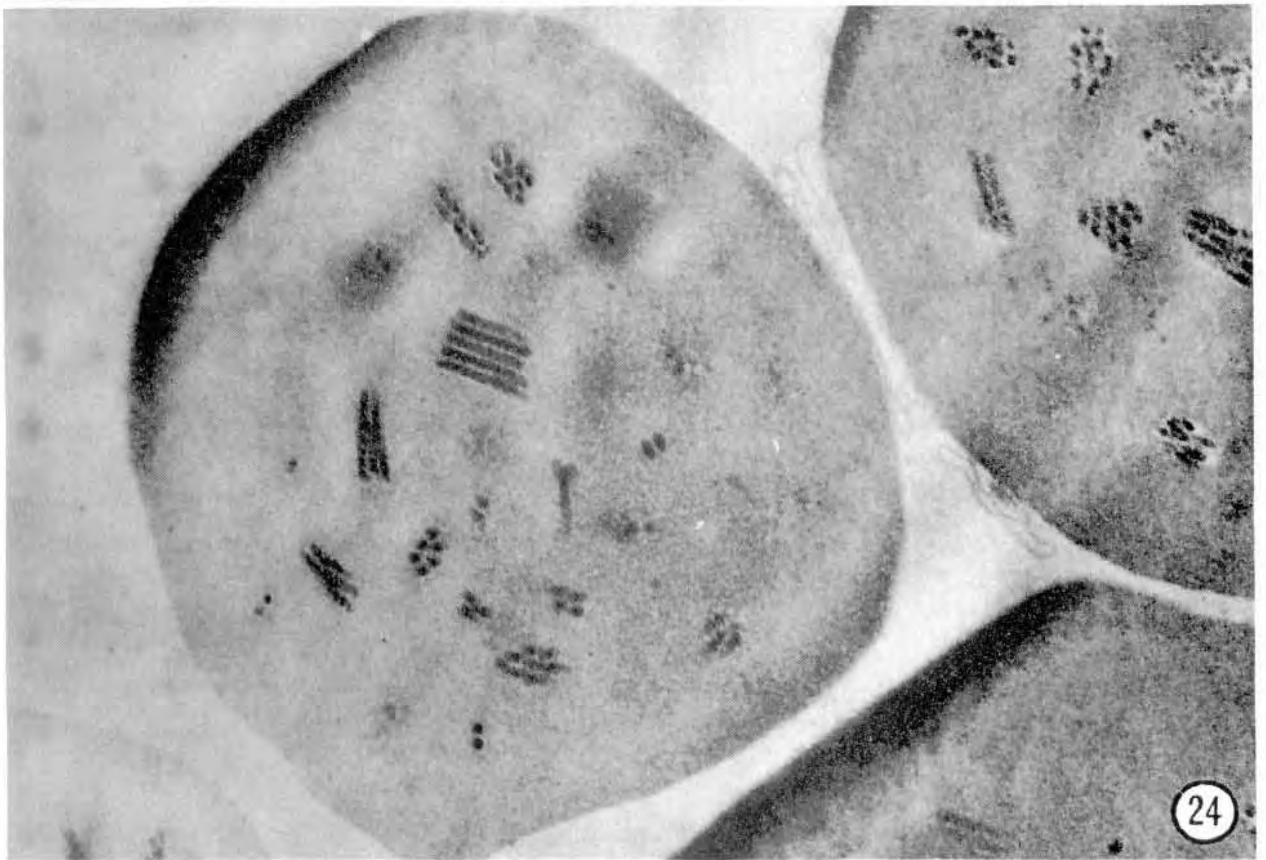
Fig. 20. Electronphotomicrograph of nuclear polyhedra of Caripeta divisata (large dark bodies), approx. 4,200X.



Figs. 21-22. Electronphotomicrographs of sectioned polyhedra of 21. Malacosoma disstria showing virus occurring singly or in bundles of 2-5 particles, approx. 61,000X; 22. Neophasia menapia showing virus occurring singly or in bundles of 2-10 particles, approx. 51,300X.



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Figs. 23-24. Electronphotomicrographs of sectioned polyhedra of 23. Vanessa cardui revealing virus occurring singly or in bundles of 2-11 particles, approx. 37,600X; 24. Acleris variana revealing virus occurring in bundles of 2-9 particles, approx. 67,000X.